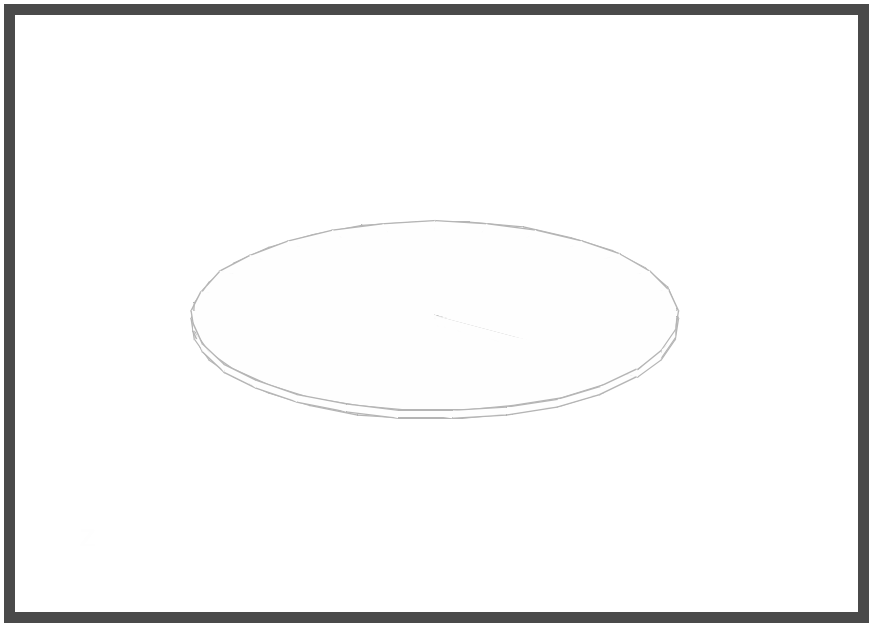
APPENDIX G

Modal Analysis of a Circular Plate (SI)



Objectives:

- Reduce the model to a 30 degree section and use symmetric boundary conditions.
- Produce a Nastran input file.
- Submit the file for modal analysis in MSC.Nastran.
- Find the first three natural frequencies and mode shapes of the circular plate.

Model Description:

For this example, use Lanczos method to find the first three natural frequencies and mode shapes of a circular plate that is fully clamped around the edge. In addition, model the circular plate by using a 30 degree section to reduce the size of the model. Be certain to incorporate all the necessary symmetric boundary conditions to ensure the accuracy of the analysis.

Below is a finite element representation of a 30^o section of the circular plate. It also contains the geometric dimensions and boundary constraints. Table G.1 contains the necessary parameters to construct the input file.

Figure G.1 - Grid Coordinates and Element Connectivities

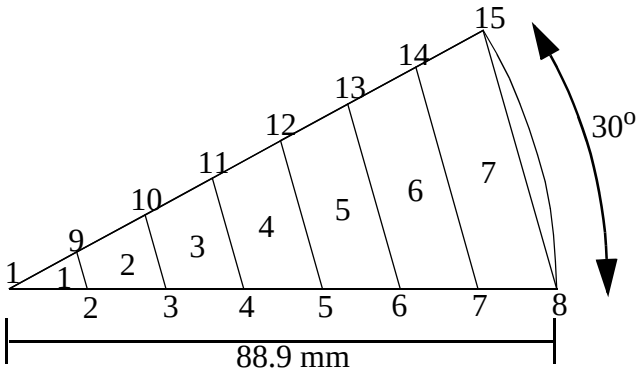


Figure G.2 - Boundary Constraints

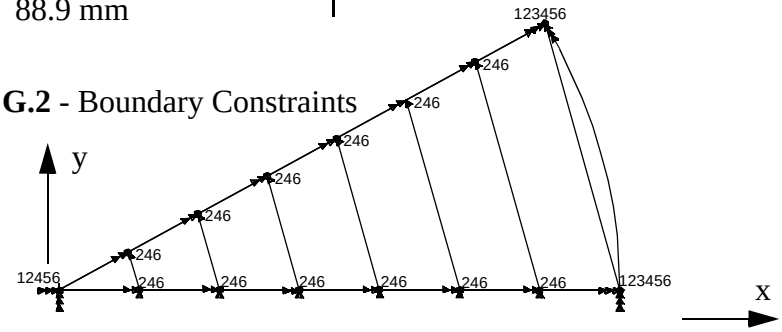


Table G.1 - Model Properties

Radius:	**88.9 mm**
Thickness:	**3.175 mm**
Weight Density:	**8304 kg/m^3**
Mass/Weight Factor:	**1.02E-04 sec^2/mm**
Elastic Modulus:	**207 GPa**
Poisson Ratio:	**0.3**

Suggested Exercise Steps:

- Build the plate geometry as shown in Figure G.1 on the XY plane.
- Generate a finite element representation of the plate structure i.e., the nodes (GRID) and element connectivity (CQUAD4 and TRIAD3).
- Create a cylindrical coordinate system for applying constraints, both actual and for symmetry conditions.
- Define material (MAT1) and element (PSHELL) properties.
- Apply a clamped boundary constraint (SPC1) to the outer curved edge, and symmetric boundary constraints (SPC1) to the two straight inner edges.
- Prepare the model for a normal modal analysis using Lanczos Method (SOL 103 and PARAMs).
    - PARAM, COUPMASS, 1
- Generate an input file and submit it to the MSC.Nastran solver for normal modal analysis.
- Review the results, specifically the eigenvalues.

Generating an Input File for MSC.Nastran Users:

MSC.Nastran users can generate an input file using the data from Table G.1. The result should be similar to the output below.

1. MSC.Nastran Input File: **ex06plate.dat**.

```
ID  MODAL AN,CATIAFEM
SOL     103
CEND
$..
$-------------------------------------------------------------------------------
$..
$..                   CASE CONTROL DECK
$..
TITLE = MODAL ANALYSIS OF A CIRCULAR PLATE
DISPL   =       ALL
METHOD  =       1
MPC     =       1
$..
SUBCASE =        1
$ CATIA RESTRAINT SET NAME :
$ RESTRAINT1
   SPC  =        1
$..
$-------------------------------------------------------------------------------
$..
$..                   BULK DATA CARDS
$..
BEGIN BULK
EIGRL,1,,,3
PARAM,COUPMASS,1
PARAM   POST    1
PARAM   AUTOSPC YES
$..
$-------------------------------------------------------------------------------
$..
$..                   COORDINATE SYSTEMS
$..
$ COORDINATE SYSTEM NAME : AXIS1
CORD2C  1               0.      0.      0.      0.      0.      1.              1
+      188.9    0.      0.
$..
$-------------------------------------------------------------------------------
$..
$..                   RESTRAINTS
$..
$ NASTRAN ID =        1 / RESTRAINT SET NAME :
$ RESTRAINT1
SPC1    1       123456  1       2
SPC1    1       12456   15
```

```
SPC1    1       246     3       4       5       6       7       8               2
+      29       10      11      12      13      14
$..
$-------------------------------------------------------------------------------
$..
$..                   MATERIALS
$..
$ MATERIAL NAME : STEEL
MAT1    1       207000.         .3      .8304-8
$..
$-------------------------------------------------------------------------------
$..
$..                   NODES
$..
GRID    1               76.9896644.45   0.      1
GRID    2               88.9    -.252-140.      1
GRID    3               65.6031537.876  0.      1
GRID    4               75.75199-.323-140.      1
GRID    5               54.2166431.301990.      1
GRID    6               62.60399.1393-140.      1
GRID    7               42.8301324.727990.      1
GRID    8               49.45598-.287-140.      1
GRID    9               31.4436218.153990.      1
GRID    10              36.30797-.183-160.      1
GRID    11              20.0571211.579980.      1
GRID    12              23.15996.2708-140.      1
GRID    13              8.6706075.0059780.      1
GRID    14              10.01196.2002-140.      1
GRID    15              0.      0.      0.      1
$..
$-------------------------------------------------------------------------------
$..
$..                   ELEMENTS
$..
CTRIA3  1       1       15      13      14
CQUAD4  2       1       13      11      12      14
CQUAD4  3       1       11      9       10      12
CQUAD4  4       1       9       7       8       10
CQUAD4  5       1       7       5       6       8
CQUAD4  6       1       5       3       4       6
CQUAD4  7       1       3       1       2       4
$..
$-------------------------------------------------------------------------------
$..
$..                   PROPERTIES
$..
PSHELL  1       1       3.175   1       1.      1       .83333
$..
ENDDATA
```

Submitting the Input File for Analysis:

2. When the run is complete, edit the **ex06plate.f06** file and search for the word **FATAL**. If no matches exist, search for the word **WARNING**. Determine whether existing WARNING messages indicate modeling errors.

3. While still editing **ex06plate.f06**, search for the word:

   E I G E N (spaces are necessary)

   1st = _____Hz

   2nd = _____Hz

   3rd = _____Hz

Comparison of Results:

4. Compare the results obtained in the **.f06** file with the results on the following page:

0 SUBCASE = 1

R E A L   E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIANS	CYCLES	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	3.791086E+07	6.157180E+03	9.799456E+02	1.000000E+00	3.791086E+07
2	2	6.076836E+08	2.465124E+04	3.923367E+03	1.000000E+00	6.076836E+08
3	3	3.379269E+09	5.813148E+04	9.251913E+03	1.000000E+00	3.379269E+09